Model Biases in Southeastern US Precipitation

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Southeast US - A Complex Area!

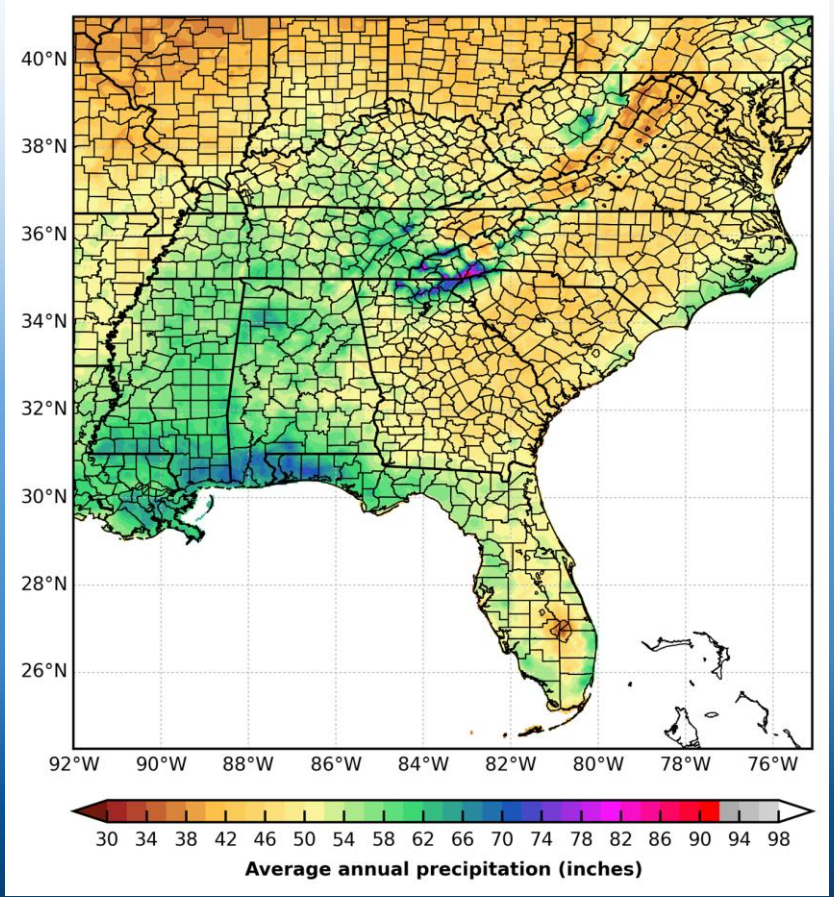

Figure: Annual Mean Precip in Inches (2002-2014) from PRISM
https://sercc.com/prism_maps/Southeast_average_annual_precip_2002_2014.png

Southeast US - A Complex Area!

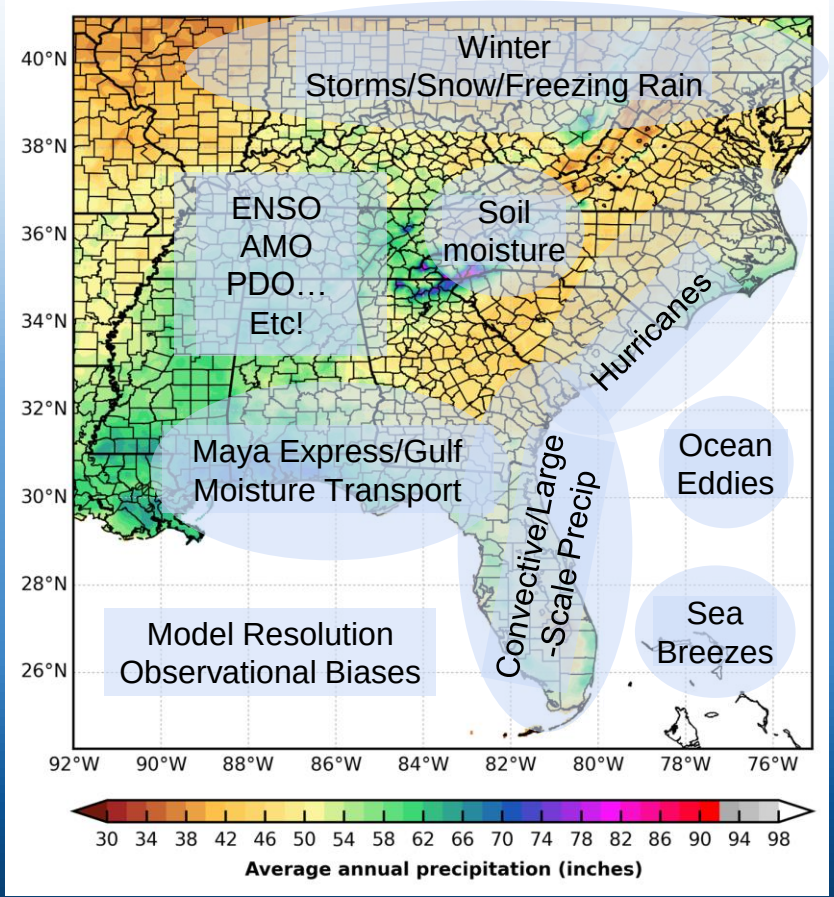

Figure: Annual Mean Precip in Inches (2002-2014) from PRISM
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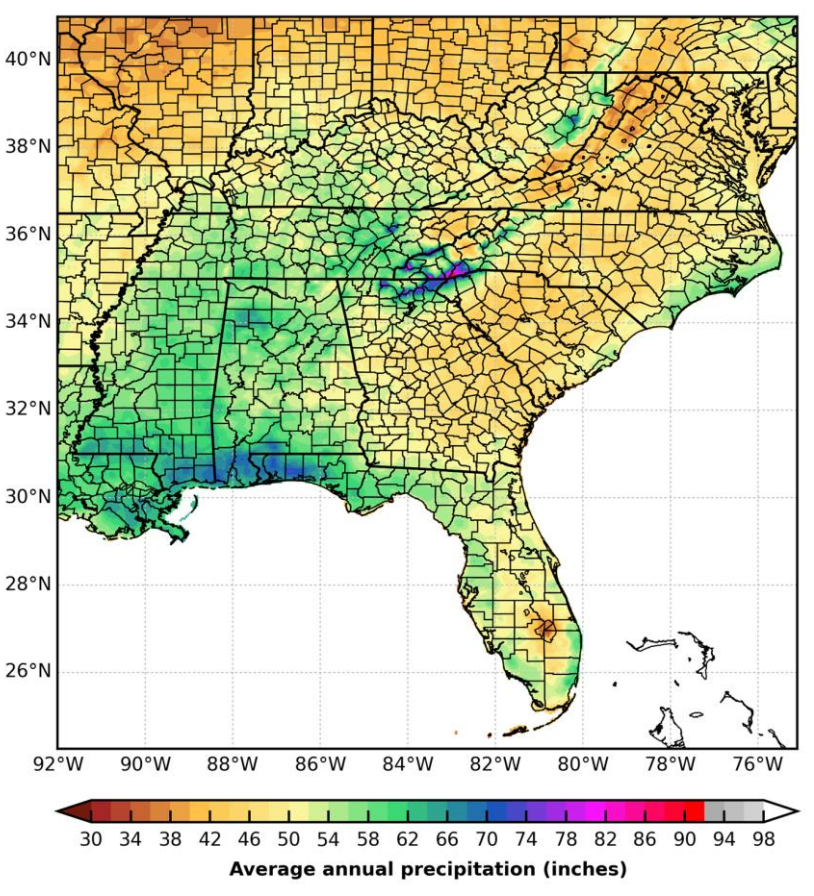
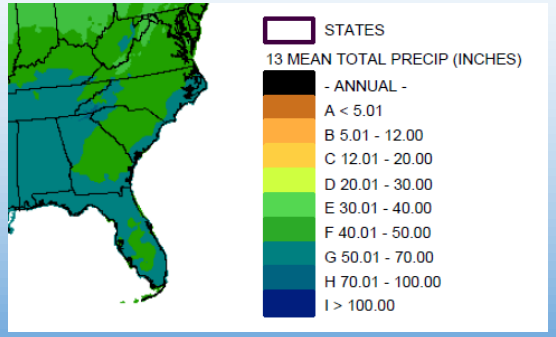
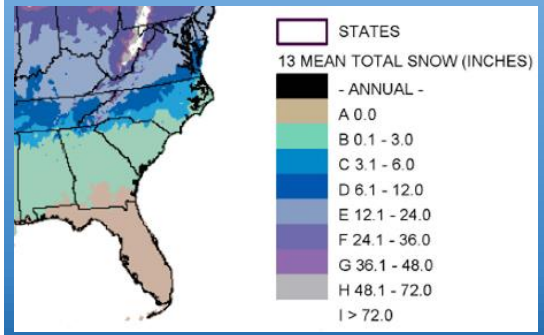
Disclaimer: These key drivers/challenges are not necessarily specific to the area highlighted, and of course, operate on scales ranging from sub-seasonal to seasonal

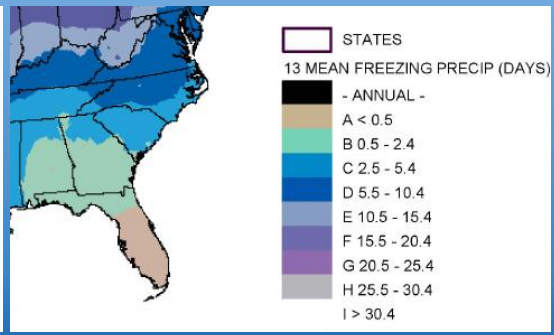
Models are Imperfect: All of these (can/may) drive model biases!

Southeast US - Precipitation Types









Left Figure: Annual Mean Precip in Inches (2002-2014) from PRISM
https://sercc.com/prism_maps/Southeast_average_annual_precip_2002_2014.png

Top Figures: Annual Mean Precip, Snow, Freezing Rain from NCDCC (1961-1990)
https://climate.ncsu.edu/edu/SEPrecip

Precipitation Drivers (A Sampling)

Subseasonal (and shorter)

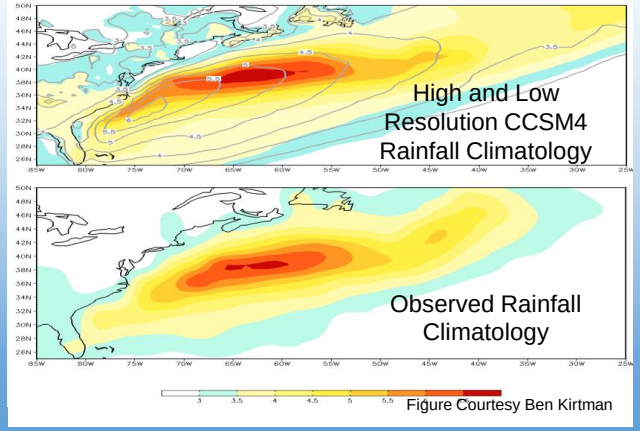
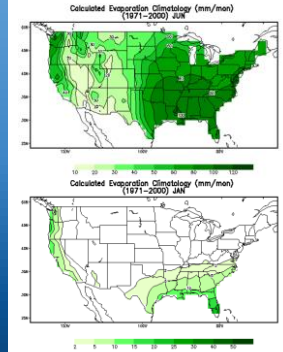


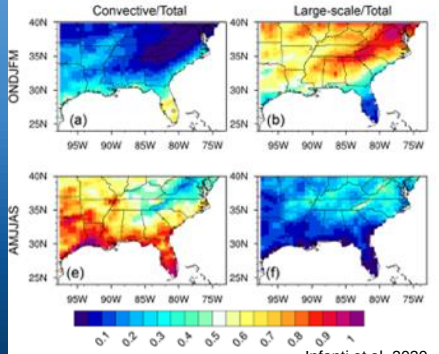
Figure Courtesy Ben Kirtman

Evaporation Climatology



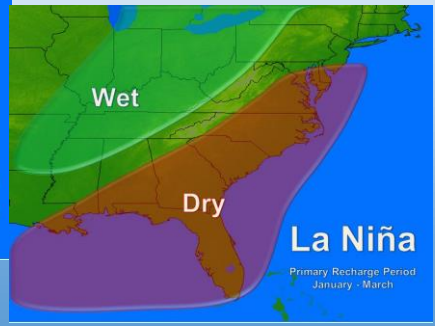
https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Evap/Evap_clim.shtml#

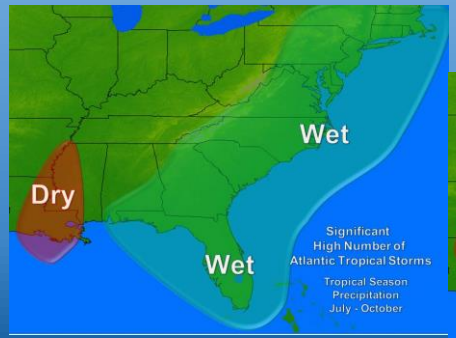
Variance Ratios of Convective or Large-Scale to Total Precip



Infanti et al. 2020

Seasonal (and longer)

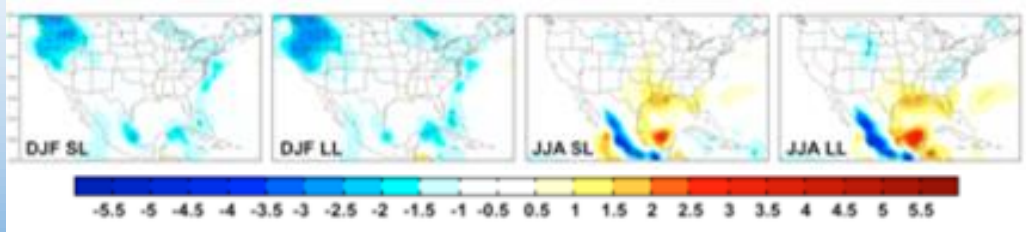




Above Figures: https://www.weather.gov/serfc/climptrns

Model Biases and Skill (Focus on Seasonal)

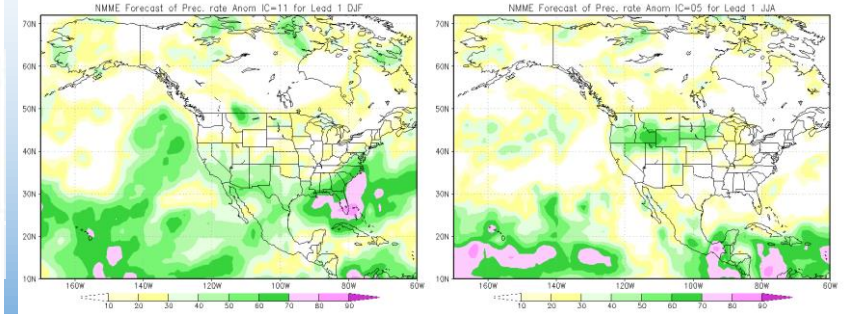
NMME systematic biases for DJF, JJA short (SL) and long lead (LL) precip forecasts



Infanti and Kirtman 2013

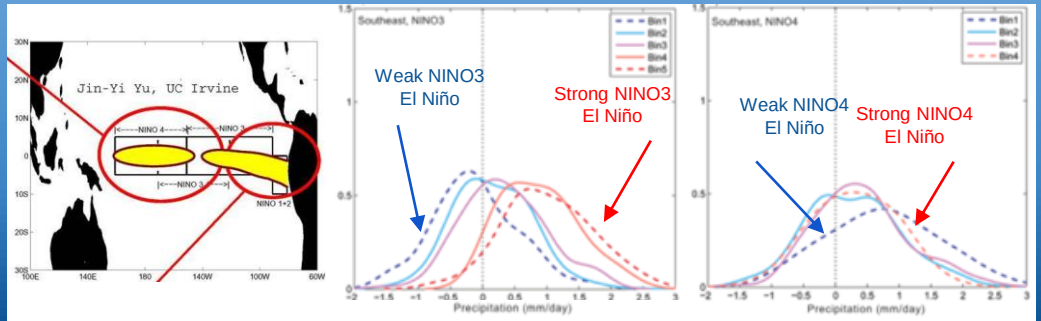
Biases in spring/summer are larger than winter, but also consistent across leads - Any error structure sets in rapidly

NMME Anom Correlation for DJF, JJA lead 1 precip hindcasts



https://www.cpc.ncep.noaa.gov/products/NMME/

Much of the winter skill is due to ENSO (e.g Shukla et al. 1998) and forecasts of opportunity

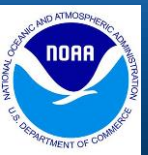


Southeast US Precip “tracks” with the strength of NINO3 El Niño events (Infanti and Kirtman 2015). Models have bias during CP events (e.g. Capotondi et al. 2014)

What are some key areas to improve?

- **While we can use calibration methods to correct systematic bias statistically, there are still areas to improve!**
- **Model representation of and response to key drivers**
  - While ENSO is already somewhat skillful, there is room to improve as models still have bias on periodicity, strength, and location of ENSO events, which can lead to false alarms/misses in forecasts (statistical bridging to correct teleconnections, e.g. Schepen et al. 2016, Strazzo et al 2020, Infanti et al. 2021 (in prep) helps, but there is of course more to be done!)
- **Model Resolution**
  - Despite being (somewhat) able to capture the large-scale climatology, some of the finer details are missed by models, including representation of convective scale precipitation, sea-breezes and or coastal processes, and granularity of responses to teleconnections or local drivers
- **Even with the above, observational datasets vary in their representation of precipitation - what is “truth”?**

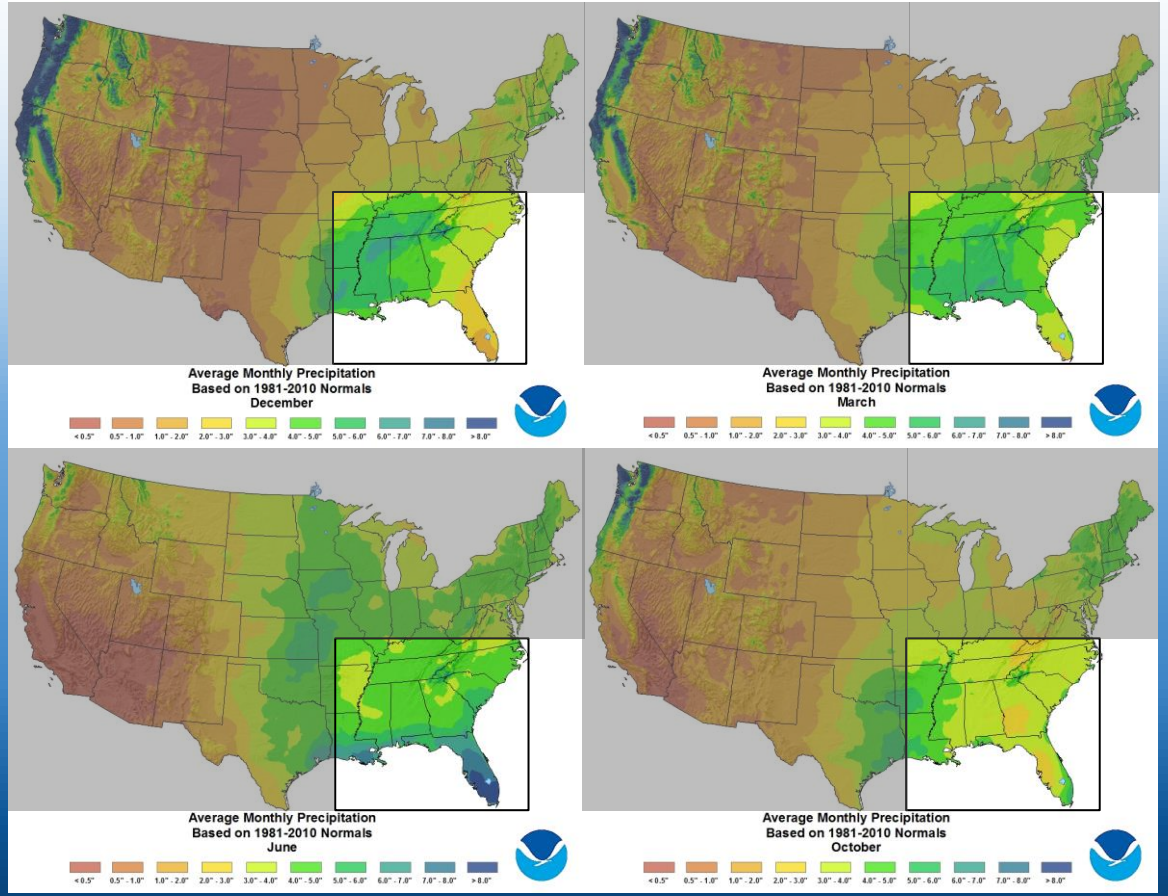
Extra Slides



Outline (from Angie and Vijay)

- What is the regional distribution of climatological precipitation, and what are its key drivers?
- What is the climatological seasonality of precipitation, and what are its key drivers?
- What aspects of or phenomena associated with precipitation are the most predictable in a region of the US?
- What aspects of or phenomena related to precipitation in a US region present the greatest challenge for prediction, and on what timescale does this play out?
- Which precipitation phenomena are highly impactful in a specific region, but have received less study due to lack of nation-wide concern?
- In which region are precipitation predictions most skillful currently?
- In which region could the most progress on improving precipitation be made in the short- to-medium term?
- In each region, on what timescales are improvements in predictability of precipitation most needed? And most feasible?
- What are recent and upcoming field campaigns with a regional focus? What phenomena, timescales, and seasons do they target?
- What observations that we are currently collecting are most valuable for precipitation? Which that are lacking would be most useful? what monitoring products would be useful regionally? What field campaign measurements would expand our understanding?
- Examples of regional precip phenomena:
    - Propagating convection (plains)
    - Lake effect snow (mid west)

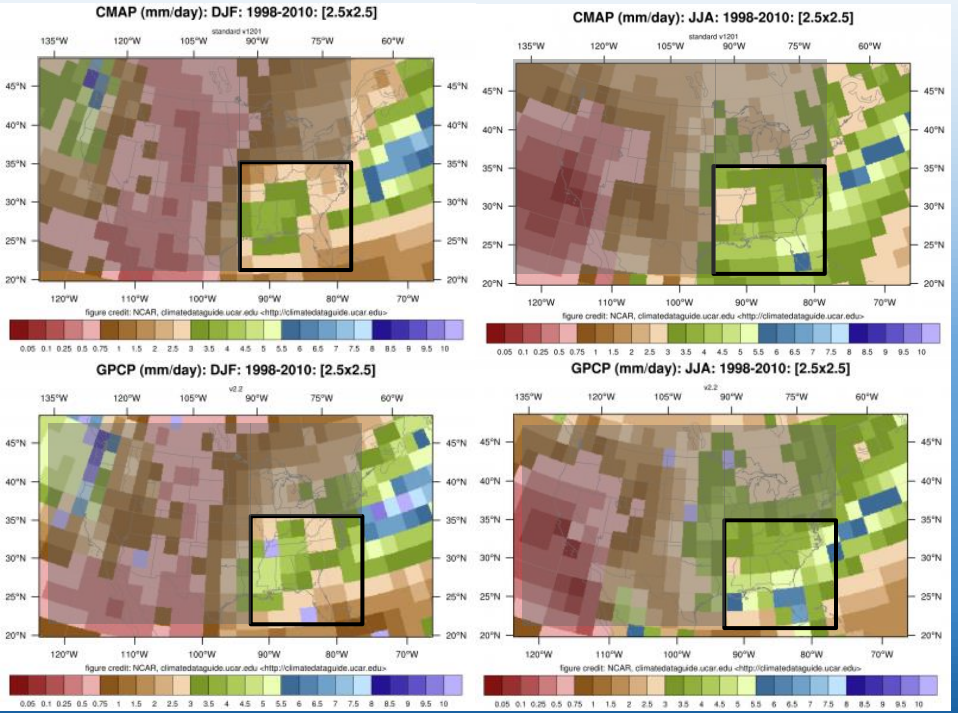
Southeast US - Seasonal Distribution of Precip

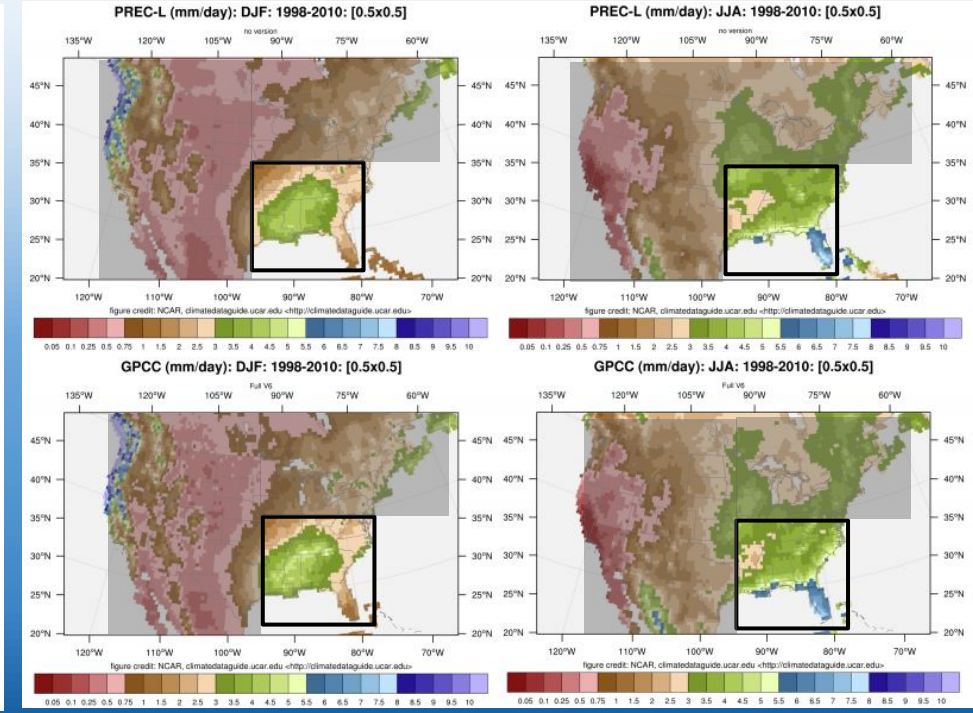


Not only do we have multiple drivers and different types of precipitation, but the seasonal distribution is also quite variable across the region

Images Courtesy:
https://www.ncdc.noaa.gov/climateatlas/

Observed Biases





Figures Courtesy: https://climatedataguide.ucar.edu/climate-data/precipitation-data-sets-overview-comparison-table

Discussion Topics

- **Global Modeling vs. Regional Modeling**
  - While global models may show overall skill, intricacies of certain regions can be missed in favor of getting large-scale patterns correct - For example, convective scale precipitation and sea breezes in Florida are not resolved, and precipitation forecasts are biased/unskillful
- **Where do we need to focus our efforts?**
  - **Is resolution the answer?** How much skill increase or value added do we gain from increasing model resolution? While we may better resolve small scale precipitation features, most references point to better representation of total precipitation in high-resolution atmospheric models, rather than better representation of convective precipitation (Wehner et al. 2014; O'Brien et al. 2016; Shields et al. 2016)
  - **Downscaling?** If resolution is important, it is increasingly possible to run global simulations at higher resolution from the onset, but computing resources are always an issue. Could or should downscaling be used, and statistical or dynamical (or a hybrid)?
  - **Better representation of remote divers?**
  - **Better representation of local drivers?**
  - **Solidifying our observational data?**